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SCOTINOPHARA COARCTATA, F. (The Black Bug of Padi).

By G. H. Corbett and Mohammed Yusope.

Introduction.

THE principal sucking insects which attack Padi in Malaya from time to time are *Leptocorisa* spp. which reduce the yield by sucking the sap from the developing grain, *Nephotettix bipunctatus*, F. which sucks the sap from the leaves and stems and is occasionally responsible for causing considerable damage to the padi plant, and *Scotinophara coarctata*, F. In certain districts, this bug is liable to cause more damage than any other insect pest of padi, since it may entirely prevent the formation of grain by sucking the sap from the stems of the plant, and owing to the difficulty attending its control where water is unavailable, cultivators are often helpless when it increases to large numbers. The natives of Malaya consider that this insect lives naturally on grasses in the jungle, and support for this belief has been obtained in the field at Pekan in Pahang, Parit in Perak, and Kundang in Selangor, where outbreaks of *S. coarctata* occurred on padi which had been planted just after the jungle had been felled.

Dialect names in Malaya for *S. coarctata*.

Kutu bruang	...	A bear-like bug.
Benah kura	...	A tortoise-like pest.
Kutu ayer	...	A water bug.
Kepending ayer	...	A water bug. (in Sumatra).
Jebat	...	An insect having the smell of a civet cat. (in Kedah).

Historical.

The first reference to *Scotinophara coarctata* being injurious to Padi which has been traced in our available literature was in the Salem district of India in July, 1907, but it was not till October, 1918, that the damage caused by this insect was reported to the Department of Agriculture, Federated Malay States. Inche Abdul Rahman, who was Sub-Inspector of Coconuts in Pekan, Pahang, wrote to the Chief Agricultural Inspector, Mr. F. W. South, to the effect that this insect attacked "wet" and "dry" padi in every Pahang river Mukim of the Pekan District, and he had tried to treat it with a weak solution of Izal. On the 15th. November, in reply to a Memorandum from the Chief Agricultural Inspector, he forwarded specimens of the insects and stated that they were called by the Malay "Kutu bruang bangsa amping"* Correspondence continued between the Chief Agricultural Inspector, the Acting Government Entomologist, (Mr. P. B. Richards), and the Sub-Inspector of Coconuts, Pahang. On the 10th. December, 1918, a telegram was received from the District Officer, Pekan. "Junior Agricultural Assistant reports extensive damage by 'Kutu bruang.' Sample sent last mail. Is it possible to send some one to assist taking preventive measures ?" In reply to this telegram recommendations were made for the control of the insect, and the junior author was instructed to leave Kuala Lumpur in August, 1919, for Pekan. He was stationed there for five months making preliminary observations and investigating the habits of this insect. On the 2nd. September, 1919, the then Assistant Agricultural Inspector for Negri Sembilan and Pahang, (Mr. D. H. Grist), received a report from a Malay in Kuantan that "these insects make their nests in the nursery bed and lay their eggs down there just in the stems of the seedlings, and the nests look like the nests of "Penyengat Daun" (small leaf wasp). In one of these nests there will be hatched about ten young "Kutu bruang." For the lack of knowledge about these nests by the native growers, when they remove the seedlings for transplanting, the nests are carried along with them. This pest was first found in Kampong Darat, Kubang Buaya and Alor Tok Sera. I am sending you under separate cover young padi plants destroyed by this pest and also its eggs."

Economic Importance.

The economic importance of this insect may be gauged from a letter written by the District Officer, Pekan, dated October, 1920, to the Secretary to Resident, Pahang, who stated that "the rice pest—a sucking bug known as "Kutu bruang" or *Podops*—has this year been as rife as ever in this District. I am unable to say the extent of the damage caused by its depredations—they are still in process—but it is certain that nearly every padi field is being attacked and that many will bear nothing. During the last few years this pest seems to have grown annually worse, and I noted in my report for 1918 that whole areas were wiped out by this disgusting bug."

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* A bear-like bug similar in appearance to toasted padi grain.

Nature of Injury.

Adults and nymphs after the first moult suck the sap from any portion of the padi plant, but especially from the bases of the stems, and if in large numbers so weaken the vitality of the plants that seed is not produced. In severe attacks the plants are stunted, the leaves reddish brown in colour, and only occasional plants with panicles may be seen throughout the field. If this insect is in small numbers, little noticeable injury is observed. The following figures are given as an indication as to the number of nymphs and adults on padi plants considered to be suffering slightly and severely from the continuous extraction of sap. In Count No. (1), the leaves were slightly reddish in colour. In Count No. (2), the leaves were decidedly reddish-brown in colour and very few healthy leaves were seen. In each Count ten plants were taken.

Count.	Number of plants.										Number of nymphs and adults present.	Average number on each plant.
	1	2	3	4	5	6	7	8	9	10		
No. (1)	20	12	2	2	5	26	10	7	7	9	100	10
No. (2)	24	107	83	57	96	59	33	78	65	71	673	67.3

S. coarctata being capable of rapid increase, the plants in Count No. (1) may after a short time have possessed a similar number of the stages and have borne the same appearance as the plants in Count No. (2).

Owing to the difficulty of dissociating other causes—insects, soil and moisture—in reducing the yield of the padi, the loss due to the agency of the various stages of *S. coarctata* cannot be estimated, but when present only in slight numbers the vitality of the plant is weakened so that a reduction in yield, though possibly small, occurs, and in large numbers sufficient seed may not be produced to repay the expenses of harvesting.

Distribution.

In Distant's Fauna of India, Rhynchota, Vol. 1., *Scotinophara coarctata*, is recorded under the name of *Podops coarctata*, in "Tranquebar, Ceylon, Burma, Rangoon, Bhamo, Teinzo, also a common species in the Malay Peninsula and received from Java."

In Malaya this insect has been recorded from the States of Kelantan, Pahang, Perak, Negri Sembilan and Malacca, but the extent of the damage to padi varies considerably in different localities.

Description of the Egg and Instars.

Egg. (fig. i, a, b.)

The egg, with the exception of the operculum, is shiny pale greenish grey in colour, cylindrical in shape and finely reticulated. In colour, the top is greyish white, indicating the cap which splits to allow the nymph to emerge.

The egg measures about 1 millimetre by .6 millimetre. The measurements of 100 eggs gave the following averages :—Shorter axis .65 millimetre, longer axis 1 millimetre. The longer axis is at right angles to the surface of attachment. The egg increases very slightly in size during its development. When the egg is about two days old, the colour changes to greyish pink, on the day before hatching the whole egg is whitish pink in colour, but the cap is more pink with two distinct pink lateral spots on the margin corresponding to the eyes of the developing nymph.

Nymphal Stages.

The young bug in the course of its life moults five times, increasing in size after each moult and acquiring wings at the fifth.

First Instar. (Fig. ii.)

The young nymph on hatching from the egg has the head, thoracic segments, and markings on the mid-dorsum and connexivum brown, whilst the abdomen between the mid-dorsum and the connexivum is yellowish green with black spots. It is oval in shape, broadest across the middle of the abdomen and narrowest across the head. Newly emerged, the nymph measures about .64 millimetre in length and .51 millimetre in width, but after two days about 1.2 and .80 respectively. It is distinctly convex on the dorsal and slightly convex on the ventral surface.

The head is bent slightly downwards. The eyes, placed laterally, are red and prominent. The four-jointed antennae are yellowish brown : the basal portion of the first joint slightly pink, and the apical portion of the fourth, which is swollen, dark brown in colour. The proboscis extends about half the length of the body, reaching the second abdominal segment.

The thorax is dark brown in colour, the prothoracic segment being the longest ; the legs are hairy and yellowish brown in colour, the tarsi 2-jointed terminating in two small hook-like claws. A central demarcation, more prominent on the thoracic segments may be followed to the last adbominal segment.

In a short time, the abdomen assumes a distinct reddish brown colour which is especially noticeable between the abdominal markings.

The abdomen has nine segments, and although the divisions are difficult to follow, each segment would seem to carry a somewhat rectilinear marking. The third marking is longer and broader than the first two but shorter than the fourth and fifth, and the latter is slightly longer than the former but more rounded at the distal end. The sixth, seventh, eighth and ninth markings on their respective segments seem to coalesce in some specimens.

Second Instar. (Fig. iii.)

After the exoskeleton has hardened, the second stage nymphs wander actively and commence to feed. If they are not supplied with food soon after moulting death rapidly ensues.

The second stage nymph measures 1.75 millimetre in length and 1.00 millimetre in width. At first the general colour is distinctly pink in appearance but later a darkish brown colour is more in evidence. The whole body especially the abdomen possesses depressions.

The head is more pronounced and is light brown in colour. The apex of the fourth joint of the antenna is almost black.

The thorax is light brown at the mid-dorsum and between the margin and mid-dorsum dark shiny brown.

The abdomen is pinkish brown in colour with the exception of the markings which are dark brown and the connexivum which is light brown. The third, fourth and fifth markings are conspicuous, the first and second are difficult to make out. On each of the fourth and fifth markings there are two lateral openings indicating the pores of the repugnatory glands.

In this stage nymph, the segments of the abdomen are more prominent at the connexivum.

Third Instar. (Fig. iv.)

The third stage nymph measures 2.8 millimetres in length and 1.9 millimetre in width. The antennae are brown and the eyes are dark purplish red. The head and thorax are yellowish green pitted with red depressions. The prothorax has one, the mesothorax two and the metathorax one lateral greenish brown marking on each side.

The abdomen is light yellow with red depressions and streaks. The third, fourth and fifth markings are prominent and greenish brown in colour.

Fourth Instar. (Fig. v.)

The fourth stage nymph measures 5 millimetres in length and 3 millimetres in width.

The colour of the thorax is dark brown : the greenish areas mentioned in the third stage have changed to light brown. The mesothoracic segment shows a central and two lateral projections indicating the scutellum and the hemelytra of the adult. The abdomen is olive green in colour with red depressions and reddish markings at the divisions of the segments.

Fifth Instar. (Fig. vi.)

The fifth stage nymph measures 7 millimetres in length and 3.75 millimetres in width. The colour of the thoracic segments is darker brown than that of the fourth stage nymph. The eyes are almost black in colour. On the pro-and meso-thoracic segments is a pair of yellow coloured markings.

Projections are now seen from the metathorax, and those from the mesothorax are more prominent. The third, fourth, and fifth, markings on the abdomen are conspicuous, and around these markings the colour is yellow, whilst the remainder of the abdomen is brownish red diffused with yellow ; the pits are dark brown.

Sixth Instar.

The Newly Emerged Adult.

Newly emerged the adult appears white, has red oculi and pinkish coloured ocelli. Closer examination shows the scutellum and abdomen to be tinged with green and to possess numerous pink spots and markings. The antennae are five-jointed, the second and fourth being pinkish in colour, and the first, third and fifth white. Later, the adult becomes grey, then reddish brown, and finally black.

The Adult. (Fig. vii.)

The size varies only slightly in different specimens, the average size is 9 millimetres from the anterior margin of the head to the apex of the abdomen, and 4.5 millimetres across the broadest part, viz :— the prothorax.

The ground colour of the dorsal surface is deep brownish black to black and shiny, while the ventral surface is dull black. On this ground colour there are lighter markings of yellowish brown.

The head is black without yellowish brown markings, 1.25 millimetre in length, longer than broad. The antennae, arising from lateral projections are five-jointed ; the first joint is stout and .4 millimetre in length, the second joint is slender and .4 millimetre in length, the third and fourth joints are .55 millimetre in length, and the fifth joint is .9 millimetre in length and swollen. The two black compound eyes are very conspicuous on the lateral margins, and the two ocelli, in line with the posterior margins of the compound eyes, are dark reddish brown in colour.

The pronotum is broadest about two thirds from the anterior margin, narrower anteriorly than posteriorly with two projections on each side, one on the anterior margin and one on the broadest part. Odoriferous apertures may be seen between the second and third pairs of legs on the metasternum.

The scutellum, which almost reaches the apex of the abdomen, narrows and then broadens out at one third of its length from the base and is rounded at its apex. It has the appearance of being black with brown markings, but removed from the insect it is dark tortoise shell colour. The corium and clavus of the hemelytra are of the same colour as the scutellum.

The ventral surface of the abdomen is dull black with yellowish brown spots. The tibiae and tarsi are light yellowish brown in colour, the other joints black. The tarsi are 3-jointed.

The male is usually slightly smaller than the female, and in the male the membranes of the hemelytra extend to the tip of the abdomen, whilst in the female they stop short of the apex, exposing the abdomen which appears as a lightish band on the dorsal surface.

Deposition of the Egg.

The eggs are laid in groups varying in number from 22 to 66. Records of 143 egg masses gave an average of 38.1 eggs in each group, fifty of these masses containing from 40 to 49 eggs. The eggs are fixed at the point of their attachment and to one another by a gummy substance, and are arranged in longitudinal rows somewhat corresponding to the ridges on the leaves of the plant. The eggs in one row fit between the eggs of the next row. There are generally more eggs in the central row than in the rows on either side, giving the group a somewhat hexagonal appearance.

When padi is growing under "dry" conditions, the eggs are generally found towards the base of the plant, and are sometimes laid in the cracks of the soil and on the roots; in flooded areas, they are laid on the lower leaves or even further up the stem. In the insectary, a certain degree of moisture was found to be required for the incubation of the egg. If this was not present, the eggs turned black and did not hatch. The place of deposition might be explained by the fact that the adult deposits her eggs where sufficient moisture is present for the successful emergence of the nymph from the egg.

The eggs are mostly laid at night and rarely during the daytime.

Incubation of the Egg.

When the nymph is about to emerge from the egg, the egg splits all round the cap with the exception of a small hinge-like

portion. In the majority of cases, after the emergence of the nymph, the lid falls back to its original position leaving a circular split. The reticulation is more pronounced in the empty egg shell.

There is a very slight difference in the incubation period of the eggs in one mass and from one group to another.

INCUBATION PERIOD.

Month eggs laid.	Number of eggs under observation	Number of eggs and the day they hatched after deposition.			
		Day 4.	Day 5.	Day 6.	Day 7.
1920.					
December	47	—	26	21	—
1921.					
January	38	—	—	—	38
February	112	—	72	40	—
March	226	—	56	170	—
April	114	—	89	25	—
May	145	—	90	55	—
June	50	—	—	25	25
July	125	56	69	—	—
August	123	20	48	55	—
September	24	—	24	—	—
1922.					
July	646	—	264	382	—
August	198	42	—	156	—
September	1782	725	889	153	15

Out of a total of 3630 eggs, 843 hatched on the fourth, 1627 on the fifth, 1082 on the sixth and 78 on the seventh day. Occasional eggs have been recorded as hatching on the eighth day, but this was probably due to the eggs having been kept under dry conditions.

EGGS LAID BY INDIVIDUAL FEMALES.

Observations concerning the egg-laying capacity of individual females were made on a large number of occasions. A female and male attaining adult condition on the same day were placed together in the same cage. If the male died another one was introduced. The following table gives the number of eggs laid by seventeen females.

Date nymphs attained adult condition.	Number of days elapsing before first egg-laying.	Laying periods in days.	Number of eggs laid.	Number of days between last egg-laying and death of the female.
1922.				
Aug. 23	10	106	400	76
26	21	96	478	90
27	9	112	435	50
27	11	87	528	64
28	20	95	379	38
28	18	84	435	25
29	21	92	384	43
29	22	72	394	115
29	19	94	388	7
29	11	109	443	77
29	22	87	374	7
30	16	56	303	21
31	16	89	602	42
31	17	91	416	3
31	12	104	684	58
Sept. 2	13	95	403	104
2	13	110	628	76

The preoviposition period will be seen to vary from 9 to 22 days. The maximum number of eggs laid by an individual female was 684 through an egg-laying period of 104 days. The interval between successive layings varied considerably. Some females laid groups of eggs on consecutive days, but with the majority there was always a period of non-deposition—a general average being about seven days. The number of days elapsing between the last egg-laying and the death of the female amounted to 115 in one instance.

Life Cycle.

After the hatching of the egg, the nymphs of the first instar cluster on and around the eggs from which they have hatched and seldom wander. They feed very little if at all during this period, and in later breeding work were not supplied with padi stems until after the first moult. The cotton wool at the base of the tubes was always kept slightly moist and the nymphs might have taken advantage of this moisture. The nymphs during their growth moult five times before becoming adults and after each moult the exoskeleton or skin splits dorsally along the middle of the thorax and anterior segments of the abdomen and the new nymph pulls itself slowly out and enters another instar. The time occupied in moulting is about one and a half hours.

Complete Life Cycle.

No.	Eggs hatched.	First moult.	First instar.	Second moult.	Second instar.	Third moult.	Third instar.	Fourth moult.	Fourth instar.	Fifth moult.	Fifth instar.	Duration of nymphal stages in days.
						1921						
1	22 June	25 June	3	3 July	8	9 July	6	14 July	5	23 July	9	31
2	22 do.	25 do.	3	30 June	5	6 do.	6	13 do.	7	23 do.	10	31
3	22 do.	25 do.	3	30 do.	5	6 do.	6	13 do.	7	21 do.	8	29
4	22 do.	25 do.	3	4 July	9	7 do.	3	13 do.	6	25 do.	12	33
5	22 do.	25 do.	3	4 do.	9	7 do.	3	13 do.	6	25 do.	12	33
6	22 do.	25 do.	3	4 do.	9	7 do.	3	12 do.	5	22 do.	10	30
7	22 do.	25 do.	3	4 do.	9	8 do.	4	14 do.	6	24 do.	10	32
8	22 do.	25 do.	3	4 do.	9	8 do.	4	14 do.	6	25 do.	11	33
9	22 do.	25 do.	3	4 do.	9	8 do.	4	15 do.	7	23 do.	8	31
10	22 do.	25 do.	3	4 do.	9	8 do.	4	15 do.	7	24 do.	9	32
11	22 do.	25 do.	3	4 do.	9	7 do.	3	13 do.	6	26 do.	13	34
12	22 do.	25 do.	3	4 do.	9	7 do.	3	12 do.	5	25 do.	13	33
13	22 do.	25 do.	3	5 do.	10	8 do.	3	14 do.	6	25 do.	11	33
14	9 July	13 July	4	20 do.	7	25 do.	5	31 do.	6	8 Aug.	8	30
15	9 do.	13 do.	4	20 do.	7	26 do.	6	2 Aug.	7	12 do.	10	34
16	9 do.	13 do.	4	20 do.	7	25 do.	5	2 do.	8	13 do.	11	35
17	9 do.	13 do.	4	20 do.	7	24 do.	4	2 do.	9	12 do.	10	34
18	10 do.	14 do.	4	22 do.	8	28 do.	6	4 do.	7	14 do.	10	35
19	24 do.	27 do.	3	4 Aug.	8	9 Aug.	5	18 do.	9	28 do.	10	35
20	24 do.	27 do.	3	4 do.	8	9 do.	5	17 do.	8	25 do.	8	32
						1922						
21	29 July	1 Aug.	3	11 Aug.	10	17 Aug.	6	23 Aug.	6	31 Aug.	8	33
22	29 do.	1 do.	3	10 do.	9	15 do.	5	21 do.	6	28 do.	7	30
23	29 do.	1 do.	3	12 do.	11	17 do.	5	22 do.	5	30 do.	8	32
24	29 do.	1 do.	3	13 do.	12	18 do.	5	22 do.	4	30 do.	8	32
25	29 do.	1 do.	3	10 do.	9	15 do.	5	20 do.	5	28 do.	8	30
26	29 do.	1 do.	3	11 do.	10	16 do.	5	22 do.	6	30 do.	8	32
27	29 do.	2 do.	4	11 do.	9	15 do.	4	21 do.	6	28 do.	7	30
28	29 do.	2 do.	4	11 do.	9	16 do.	5	21 do.	5	30 do.	9	32
29	29 do.	1 do.	3	13 do.	12	18 do.	5	24 do.	6	1 Sept.	8	34
30	5 Aug.	8 do.	3	14 do.	6	20 do.	6	27 do.	7	5 do.	9	31
31	5 do.	8 do.	3	16 do.	8	21 do.	5	28 do.	7	5 do.	8	31
32	28 do.	31 do.	3	8 Sept.	8	16 Sept.	8	22 Sept.	6	30 do.	8	33
33	28 do.	31 do.	3	8 do.	8	15 do.	7	20 do.	5	28 do.	8	31
34	28 do.	31 do.	3	7 do.	7	15 do.	8	20 do.	5	28 do.	8	31
35	28 do.	31 do.	3	7 do.	7	14 do.	7	20 do.	6	28 do.	8	31
36	28 do.	31 do.	3	8 do.	8	16 do.	8	23 do.	7	30 do.	7	33
37	28 do.	31 do.	3	7 do.	7	13 do.	6	20 do.	7	28 do.	8	31
38	28 do.	31 do.	3	9 do.	9	14 do.	5	20 do.	6	28 do.	8	31
39	28 do.	31 do.	3	9 do.	9	16 do.	7	21 do.	5	29 do.	8	32

More observations are required as to the most congenial conditions for *S. coarctata.* Nymphs emerging from the same egg mass and kept in the same cage, (their environment—temperature, food and humidity—being identical), show considerable variation in the length of time they take to become adults. In fact, soon after the first moult variation in the size of individuals is marked, and most of the later nymphal stages together with adults, which have hatched from the same egg mass, may be found together. The nymphs which remain in one instar long above the average generally die, and the same observation applies to the adults when the last nymphal stage is prolonged.

Moisture affects their development, and when nymphs are kept under dry as opposed to moist conditions the life cycle is prolonged. It would seem that in the field *coarctata* thrives best where there is stagnant water and worst where conditions are "dry," which forces the nymphs and adults to descend below the surface of the ground, usually around the roots, where a certain degree of moisture is available.

Where padi is irrigated the conditions for the breeding of *S. coarctata* are good but the adults and nymphs may be washed off the plants and distributed to other areas. Heavy rains may be responsible for reducing the numbers in some areas by knocking them off the plants and burying them in the mud in which many, especially the nymphs, would succumb.

In the Table on the opposite page only nymphs have been taken which were apparently living under healthy and suitable conditions, and have therefore completed their life cycle in the shortest time. Under adverse conditions the length of time of the nymphal stages showed considerable variation, the maximum length of the life cycle being 59 days.

The average number of days from the hatching of the egg to the first moult was 3.17, from the first to the second moult 8.13, from the second to the third moult 5.12, from the third to the fourth moult 6.23, and from the fourth to the fifth moult 9.07, giving a total of 32.02 days from the hatching of the egg to the appearance of the adult.

Longevity of *S. coarctata.*

The observations on the longevity of the male and female *S. coarctata* were made when the records on the number of eggs laid by individuals were obtained.

Longevity of Female.			Longevity of Male.		
Date nymph attained adult condition.	Date female died.	Number of days.	Date nymph attained adult condition.	Date male died.	Number of days.
1922.	1923.		1922.	1923.	
Aug. 23	Mar. 3	192	Aug. 26	Mar. 2	188
„ 26	„ 21	207	„ 27	Feb. 19	176
„ 27	Feb. 14	171	„ 28	Mar. 31	215
„ 27	„ 5	162	„ 29	Apr. 3	217
„ 29	„ 1	156	„ 29	Mar. 22	205
„ 29	Mar. 26	209	„ 29	Feb. 24	179
„ 29	„ 14	197	„ 30	„ 1	155
„ 31	Feb. 21	174	„ 31	Jan. 17	139
Sept. 2	Apr. 2	212	„ 31	Feb. 11	164
„ 2	Mar. 20	199	Sept. 2	Mar. 3	182

The records above show that the maximum length of time for the life of the female is 212 and of the male 217 days. It should be mentioned that the above are examples of ten of the longest lived females and ten of the longest lived males.

Natural Enemies.

The adults and nymphs seem free from the attacks of natural enemies, probably on account of the odour emitted from the "stink" glands but the eggs, although the adults exercise a maternal care over them until after hatching, are only partially protected from the activities of an egg parasite and those outside the protection afforded by the body of the female will frequently be seen to be more parasitised than those directly under the cover of the parent. (Fig. I.C.D.).

A Chalcidoid parasite (unidentified) inserts her ovipositor into the eggs of *coarctata* and deposits an egg generally through the upper surface. The grub hatching out feeds inside on the contents of the bug's eggs and completes its development within the egg, finally emerging as an adult. This parasite, together with adverse climatic conditions, undoubtedly serves as a check of considerable importance in the natural control of this insect and if it were not for such agencies, this insect would probably be the most important pest of Padi in Malaya.

Parasitised eggs are easily distinguished, as their colour turns black during the development of the parasite. The cap of the parasitised egg does not split as is the case with an unparasitised egg when the young nymph emerges, but instead a hole in the shell of the parasitised egg is seen through which the parasite has escaped.

By the above two characteristics, the colour due to the development and the emergence hole of the parasite, eggs reveal the presence of this parasite in the field and should not be crushed but treated in the manner described under control.

From parasitised eggs collected in the field only one parasite from each egg has been obtained. In the laboratory when a parasite lays more than one egg in an egg of *coarctata*, there does not seem sufficient nutriment for the development of two or more grubs and, although the egg turns black in colour, on no occasion have parasites emerged. Many observations have been made concerning the length of life of the parasite and it has been found that parasites without food of any kind may live as long as 6 days, the majority existing for 4 days. If sugar is supplied, the length of life is prolonged, the parasites having been observed to live for as long as 18 days, so that in the field, where food is available, it would appear that this parasite may live considerably longer than that indicated when no food is supplied.

Life cycle of the egg parasite.

In the following records, the eggs of *coarctata* were laid in the laboratory and there was no opportunity of accidental parasitisation. Parasites were introduced on the same day of their emergence to eggs of *coarctata* laid on the same day. The parasites usually remained on the eggs for two hours when the egg mass was removed.

Date Parasites introduced and *S. coarctata* eggs laid.	Date parasites emerged.	Number of days.
Oct. 24	Nov. 1	8
,, 25	,, 4	10
,, 25	,, 3	9
,, 26	,, 4	9
,, 26	,, 3	8
,, 26	,, 5	10
,, 27	,, 4	8
,, 27	,, 5	9
Jan. 16	Jan. 25	9
,, 19	,, 28	9
,, 24	Feb. 2	9
,, 24	,, 3	10
Feb. 11	,, 20	9
,, 11	,, 19	8
,, 12	,, 19	7

From the above figures it will be seen that the parasite takes from 7 to 10 days to complete its life cycle, the majority taking 9 days.

Eggs of *coarctata* collected from the field showed that the parasites take from 3—4 days longer to emerge than the nymphs, and if reference is made to the incubation period which takes from 4 -7 days, it will be seen that the figures generally support each other.

Interesting observations were made concerning the most suitable age of the eggs of *S. coarctata* for the parasite to deposit her egg and it was found that the parasite placed on eggs of *coarctata* four or five days' old does not prevent the emergence of nymphs, but on eggs of one, two and three days' old, the grubs of the parasite are effective in destroying the contents of *coarctata* eggs.

Value of the Parasites.

The eggs of *coarctata* were first observed to be parasitised in September, 1919, at Pekan, Pahang. Subsequently, eggs indiscriminately collected from Pekan and at different places in the neighbourhood were examined in order to find out the degree of parasitisation.

Egg Masses collected in Pahang.

Number of eggs in a group.	Number of parasites from each mass.	Number of eggs in a group.	Number of parasites from each mass.
53	20	44	37
43	21	61	37
46	15	44	31
37	16	38	3
47	12	39	39
53	20	42	22
50	29	41	34
56	48	61	13
44	0	41	39
66	66	42	24
39	35	63	37
37	37	63	25
49	40	45	16
49	18	54	30
46	0	40	23

The number of eggs represented in the groups is 1433 and the parasites emerging from them numbered 787, giving a percentage parasitisation of 54.9. Attention might be drawn to the fact that two egg masses contained no parasites and three groups were completely parasitised.

From ten egg masses containing 376 eggs collected at random at Tanjong Batu in November, 1919, 142 parasites were obtained, giving a percentage of 37.7. From seven egg masses containing 308 eggs collected at Langgar in December, 1919, 150 parasites were

obtained, giving a percentage of 48.7. Out of 30 egg masses containing 1045 eggs collected at Kampong Kemahang on 26th. November, 1919, 762 eggs were parasitised, giving a percentage parasitisation of 72.9. Out of 12 egg masses containing 406 eggs collected at Kampong Sungai Matdulang, 263 eggs were parasitised, giving 64.7 as the percentage.

The above five collections of eggs at different places give an average parasitisation of 55.7 per cent. Since these records were made this parasite has been found generally distributed throughout Malaya, undoubtedly exercising a controlling influence. It is considered that the collection of egg masses and treating them in a manner to be described later would be of considerable assistance in controlling this insect.

Preventive and Remedial Measures.

The control for *S. coarctata*, unless water can be regulated, must consist almost entirely of preventive measures. In areas where *coarctata* is known to be a pest, no attempt is made to prevent the succeeding padi crop suffering from the ravages of this insect. After harvest, self-sown padi, grasses and weeds are allowed to grow until the next crop is about to be sown. Cultivators seem quite content to obtain sufficient padi to provide for their own requirements and generally demand assistance when a particular insect is working havoc with their crops, which might have been largely prevented if clean culture had been practised.

S. coarctata has been found in the jungle feeding on "Rumput Kumpai" (*Panicum myurus*), "Rumput Sendayan" (*Scleria sumatrensis*), "Menderong" (*Scripus grossus*), and other unnamed grasses or sedges; in swampy places on grass; on both "dry" and "wet" padi in the nursery and in the field; on every part of the padi plant, including root and leaf; in cracks in the soil; under the heaps of partially decayed padi and grasses prior to and after transplanting padi, under lumps of earth after the land has been ploughed for the next padi crop, and between padi seasons feeding on volunteer padi, padi stubble and grasses.

From the habits of *S. coarctata*, the importance of keeping the padi area and banks as clean as possible during the "dead" season cannot be too strongly emphasised. After the crop has been harvested all stubble should be burned and the area kept clean of all plants liable to support this insect until the next seed is sown.

Collecting.

The first consideration in the control of this insect is the destruction of all breeding places and keeping the land as clean as possible after harvesting the padi crop, the second to collect eggs, nymphs and adults from the nursery beds, to see that every seedling taken from the nursery to the field for transplanting is free from the various stages, and to pay due attention to padi after it has been planted out. The presence of *coarctata* is often revealed by the padi

showing unhealthy patches. All these areas should be very carefully inspected and if eggs and bugs are found they should be collected. Nymphs and adults are frequently found in the morning high up the plants, and when in such positions, hand nets have been used with success. The nymphs and adults collected should be placed in a receptacle containing a small quantity of kerosene oil.

The eggs are frequently parasitised, and to encourage further parasitisation they should not be crushed but placed in a box without open joints and provided with a lid. Into one side of the box a small glass tube should be inserted. The idea being that parasites emerging from the eggs and being attracted to light will be seen in the tube. The tube should be removed every day, the parasites allowed to escape and the bugs hatching from the eggs destroyed. Destroying the nymphs and adults, and treating the eggs in the manner described are most important, especially in the case where "dry" padi is cultivated or water is not sufficiently controlled. Where irrigation is practised or water can be controlled, the attacked area should be flooded. After a short time, nymphs and adults rising to the surface of the water may be collected by skimming them off the surface and dropping them into tins containing kerosene.

Light Traps.

Light traps, consisting of a round tin, about 3" in depth and 24" in diameter, containing a small quantity of water with a film of kerosene oil, in the centre of which a "Storm King" lamp is placed, have been employed on various occasions, but although *coarctata* is occasionally attracted to light, success has not been obtained in the field to such an extent that light traps can be recommended.

Insecticides.

Experiments were conducted with kerosene emulsion and "Tuba" root, (*Derris* sp.). The results obtained indicated that both these sprays have a marked killing effect on the various stages of *S. coarctata* but since the quantity required would make the operation of spraying too costly, unless *Derris* plants were grown by the cultivators, this method of combating the insect is not recommended.

Description of Plate.

Fig. I.A. Eggs of *S. coarctata*, about twice natural size.
B. Eggs of *S. coarctata*, side view, about twice natural size.
C.D. Egg mass showing parasitised eggs on the margin of the group.
Fig. II. First stage nymph (greatly enlarged).
III. Second stage nymph (,, ,,).
IV. Third stage nymph (,, ,,).
V. Fourth stage nymph (,, ,,).
VI. Fifth stage nymph (,, ,,).
Fig. VII. *Scotinophara coarctata*, F. (,, ,,).

The lines at the sides of the Figures indicate approximately the size of the insect at the various stages.

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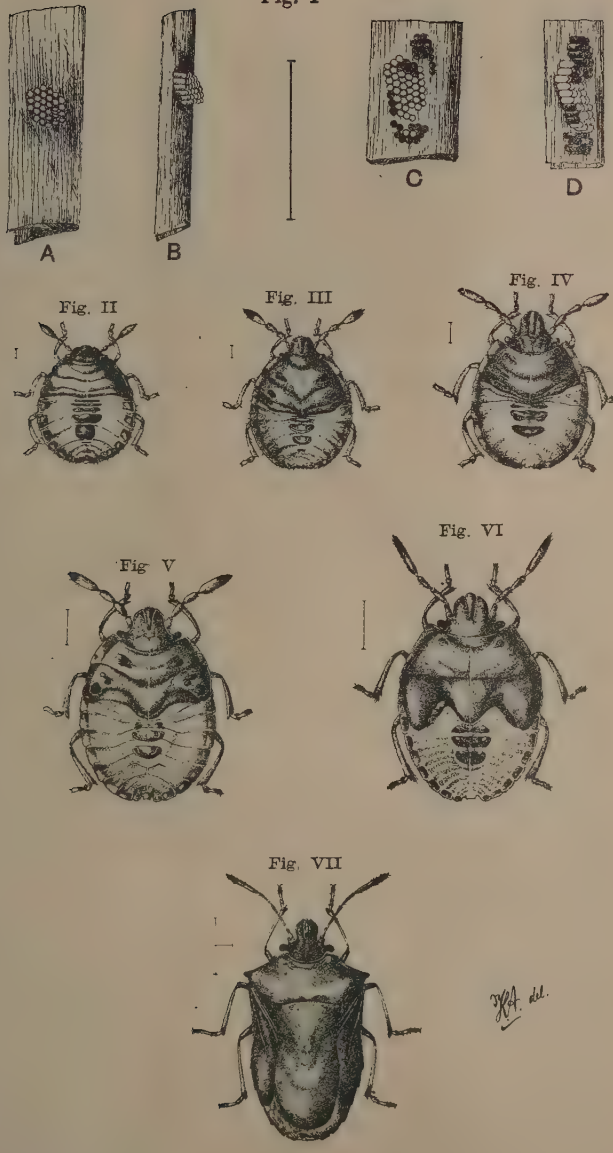

Scotinophara coarctata, F.

AN INVESTIGATION ON THE TOXICITY OF THE LIMA BEAN.

(*Phaseolus Lunatus.*)

By V. R. Greenstreet.

OWING to a prevalent idea that the Lima bean possesses toxic properties due to the presence of a cyanogenetic glucoside[1], this nutritive article of diet[2] has fallen into disfavour both in Europe and the East.

Nutritive value.

The following figures (table I) published by Bonâme[3] show the composition of the bean.

Table I.

Percentage composition of the Lima bean.

Water	Ash	Cellulose	Fat	Carbohodrate	Protein
11.70	3.70[x]	6.25	0.94	53.29	24.13

[x]containing

Phosphoric acid 24.36 per cent. Nutrient Ratio = 1 : 2.4

Potash 49.36 per cent.

Since several workers have proved that the seeds of many members of the leguminosae contain poisonous principles to a dangerous extent[4] an investigation of the toxicity of the locally grown Lima bean was undertaken at the request of the Director of Food Production with a view to encouraging its cultivation provided the results were satisfactory.

Origin.

The beans which were used in the investigation were supplied from Kuala Kangsar Government Plantation by Mr. Mathieu, who reports as follows on their origin :—

> " The Lima beans which I first planted from the consign-
> " ment received from Dreer of Philadelphia had a pronounced

1. Cyanogenetic glucoside: a complex compound which on hydrolysis (decomposition) by enzymes or possibly by the acidity of the stomach yields hydrocyanic (prussic) acid.
2. Review of Agricultural Operations in India, 1921-1922. A. H. Church. Food Grains of India, 1886.
3. P. de Sornay. Green manures and manuring in the tropics. 1916.
4. M. P. Geurin. Revue Scientifique, 1907. F. J. Warth. Memoirs Department of Agriculture of India. 1923.7.1.

"purple streak in them, so much so that in my second
"attempt I made separate beds for the seeds which were
"markedly coloured. The result at harvest was to my
"surprise a pronounced loss of colour: many of the beans
"collected had turned almost white or the colouring was
"only indicated by faint lines radiating from the hilum to
"the outer edge of the beans. In further planting, these
"lines grew fainter and fainter and in five or six generations
"the beans had become white."

The fact that the sample of white beans examined was removed by only five or six generations from the coloured ones is particularly interesting in showing the effect of cultivation, since the latter have been found to be markedly toxic[5].

Experimental.

A few ounces of the beans were ground up and made into a paste with water. The paste was divided into three fractions and each placed in a tightly corked flask as follows:—(*a*) Paste only. (*b*) Paste plus mercuric chloride. (*c*) Paste plus salicylic acid. After a few hours there was a distinct odour of hydrocyanic acid in flasks (*a*) and (*c*) while (*b*) gave no odour. This proves that the hydrocyanic acid does not exist in the beans as such, but was produced from the cyanogenetic glucoside by enzyme action. The hydrocyanic acid was subsequently estimated by Henry and Auld's method[6]. Five determinations were carried out as follows:—

1. Ground beans extracted with boiling alcohol for 4 hours.

2. Ground beans extracted with boiling alcohol for 24 hours.

3. Whole beans soaked in water for 24 hours, crushed and extracted with boiling alcohol for 24 hours.

4. Whole beans boiled until soft (2 hours), crushed and extracted with boiling alcohol for 24 hours.

5. Whole beans soaked in water for 24 hours, boiled until soft (30 minutes) and extracted with boiling alcohol for 24 hours.

The following table (II) gives the results of the determination of the hydrocyanic acid content.

Table II.

Hydrocyanic acid content of the Lima bean.

Experiment number	1	2	3	4	5
Hydrocyanic acid per cent -	0.0013	0.0017	0.0020	0.0020	0.0014

5. Society of Chemical Industry Journal. 1908. 27.428.
6. Ibid.

The amounts of hydrocyanic acid extracted in 4 hours and 24 hours (numbers 1 and 2) when plotted in a curve show that a period of 24 hours is sufficient for complete extraction.

The figures show that the Lima bean contains approximately 0.02 per cent of cyanogenetic glucoside (phaseolunatin) which upon hydrolysis yields 0.002 per cent of hydrocyanic acid. Soaking in water followed by boiling—as is usual in cooking—dissipates some of the hydrocyanic acid but either operation alone causes no reduction. Estimations numbers 1 and 2 were carried out on a different sample from numbers 3, 4 and 5 which accounts for the slight discrepancy between number 2 and numbers 3 and 4.

The lethal dose of hydrocyanic acid is stated by Witthaus[7] to be 0.05 gramme and this amount is contained in approximately 5 lbs of raw beans or 7 lbs of cooked beans. The amount of hydrocyanic acid contained in the small quantity (say 2 ounces) of beans consumed at one meal is therefore negligible and from personal experience the writer has confirmed the fact that the Lima bean is innocuous.

7. Witthaus. Manual of Toxicology, 1911.

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FRUIT.

Planting material of

THE Superintendent, Government Plantation, Kuala Kangsar, Perak, is at present in a position to supply marcots of Orange (*Citrus Aurantium*), Mango (*Mangifera indica*), and Pomegranate (*Punica granatum*), cuttings of Granadilla (*Passiflora quadrangularis*), and seedlings of the pink and the white fleshed Guava (*Psidium guajava*). Application for same should be addressed to the Superintendent.

The orange is of the Mandarine type, a small green sweet fruit. The trees at Kuala Kangsar are very prolific yielders and are recommended as a good source of planting material. It is worthy of note that the orange fruits find a very ready market in Kuala Kangsar.

Marcots of two kinds of the Indian Mango are available, one variety having large fruits and the other small. The former is the superior fruit.

F. G. S. (11-3-24.)

NOTES ON THE EXPERIMENTAL PLANTATION, SERDANG FOR THE MONTH OF MARCH, 1924.

Mr. J. N. Milsum, Assistant Agriculturist, returned from leave and assumed duty on the 29th March, 1924.

The only new planting material received during the month was a small sample of seed of Bulrush Millet (*Pennisetum typhoideum*) from the Superintendent, Government Plantation, Kuala Kangsar.

Half-acre plots of ten varieties of Groundnuts (*Arachis hypogaea*) were planted up and a comparison will be made of the yield of the different varieties when the crop is harvested.

An area of 2 acres reserved for experiments in connection with a rotation for Roselle fibre (*Hibiscus Sabdariffa* var. *altissima*) was replanted with green crops preparatory to commencing the proposed rotation which is as follows:—(1) Groundnuts (2) Roselle, (3) Cow Pea and (4) Gingelly.

Advantage was taken of the wet weather for supplying the planted areas.

An experimental sugar-cane mill was installed on the plantation during the period under review and it is expected to commence work on crushing cane next month. The mill in question has a capacity of about 5 to 6 tons of cane per day and is driven by a small 7/9 H.P. portable petrol engine.

Rain fell on 26 days during the month, giving a total rainfall of 9.36 inches. The heaviest rainfall in 24 hours was 2.44 inches.

The maximum shade temperature recorded was 97° F and the minimum 68° F. The average maximum shade temperature was 91.68° F and the average minimum 70.94° F.

Records of the cup-indicating anemometer show that the total run of wind for the month was 1546.89 miles, the average run for 12 hours from 6 a.m. to 6 p.m. 41.38 miles and that from 6 p.m. to 6 a.m. 8.52 miles.

B.B.—(12-4-24.)

LONDON MARKET PRICE LIST, 1st QUARTER 1924.

Oil Seeds.

Castor (Bombay)	-	£23.10 per ton.
Copra (Ceylon)	-	£32 „ „
Do. (Straits)	-	£30 „ „
Cotton (Egyptian)	-	£13.17.6 „ „
Do. (Bombay)	-	£11 „ „
Croton	-	27/6--32/6 per cwt.
Desiccated Coconut (fine)	-	44/- per cwt.
Do. do. (medium)	-	43/- „ „
Do. do. (coarse)	-	47/- „ „
Gingelly (Chinese)	-	£26.10—£27 per ton.
Do. (Bombay)	-	£27 „ „
Groundnuts (Gambia, undecorticated)	-	£18.10 „ „
Do. (Chinese, decorticated)	-	£23—£23.7.6 „ „
Linseed (Bombay)	-	£23.7.6 „ „
Do. (Plate, new Crop)	-	£18.2.6—£18.8.9 per ton.
Palm Kernels (West Africa)	-	£20.10 „ „

Oils.

Castor (Madras)	-	56/- per cwt.
Do. (pharmaceutical)	-	65/- „ „
Do. (1st pressing)	-	60/- „ „
Do. (2nd do.)	-	59/- „ „
Coconut (Cochin)	-	55/- „ „
Do. (Ceylon)	-	49/- „ „
Cotton seed (Egyptian, crude)	-	45/- „ „
Do. (Bombay)	-	43/6 „ „
Groundnut (Oriental, crude)	-	52/- „ „
Do. (English)	-	53/- „ „
Linseed (Calcutta)	-	48/- „ „
Do. (Plate)	-	47/- „ „
Palm (Lagos)	-	£40.10 per ton.
Do. (Sumatra)	-	£39 „ „
Palm kernel	-	42/6 per cwt.

Oil Cakes.

Coconut	-	£10 per ton.
Cotton	-	£7.10—£7.12.6 per ton.
Groundnut (undecorticated)	-	£9.10 per ton.
Linseed	-	£13 „ „
Palm kernel	-	£6.10 „ „

Essential Oils.

Cajeput	-	3/3 per lb.
Camphor (Chinese, crude)	-	3/6 „ „
Do. (Japanese, refined)	-	3/6—3/9 per lb.
Do. (Oil)	-	70/- per cwt.

Essential Oils—*Contd.*

Cinnamon (Ceylon, leaf)	-	5¾d. per oz.
Citronella (Ceylon)	-	3/6—3/7 per lb.
Do. (Java)	-	4/8 „ „
Clove	-	8/6—8/9 „ „
Lemon grass (Cochin)	-	2¾d. per oz.
Lime (West Indian, expressed)	-	7/6 per lb.
Do. (do. distilled)	-	4/6 „ „
Patchouli (Singapore)	-	21/6 „ „
Vetiver (Bourbon)	-	31/-—32/- per lb.

Spices.

Capsicums (East Indian)	-	40/-—45/- per cwt.
Do. (Nyassaland)	-	60/-—65/- „ „
Chillies (Zanzibar)	-	40/-—45/- „ „
Do. (Nyassaland)	-	50/-—55/- „ „
Do. (Japan)	-	125/- „ „
Cinnamon (Ceylon)	-	8½d.—11½d. per lb.
Cloves (Zanzibar)	-	1/3—1/5 „ „
Do. (Penang)	-	2/6—3/- „ „
Ginger (Japanese, Cochin)	-	80/-—90/- per cwt.
Do. (Jamaica)	-	145/-—185/- „ „
Mace (Bombay and Penang)	-	2/-—2/10 per lb.
Nutmegs (Singapore and Penang)—		
110's	-	1/6 „ „
80's	-	1/8½ „ „
64's—57's	-	1/8—2/- „ „
Pepper (Singapore, black)	-	4d. „ „
Do. (do. white)	-	6d. „ „
Turmeric (Bengal)	-	70/- per cwt.

Drugs.

Areca	-	45/- per cwt.
Cinchona Bark	-	According to Analysis.
Cocaine (hydrochloride)	-	17/6—18/- per oz.
Ipecacuanha (Matto Grosso)	-	10/- per lb.

Natural Dyestuffs & Extracts.

Annatto (seed)	-	1/2—1/3 per lb.
Gambier (black)	-	65/- per cwt.
Do. (cubes)	-	75/-—80/- per cwt.

Gums & Resins.

Damar (Singapore)	-	30/-—150/- per cwt.
Do. (Batavia)	-	120/-—160/- „ „
Dragon's blood (reeds)	-	£18—£20 „ „
Do. (lump)	-	£11—£28 „ „

Fibres.

Cotton (American F.L.M. to F.G.M.)	-	18.66d.—20.71d. per lb.
Do. (Egyptian Sakellaridis, G.F. to fine)	-	23.05d.—25.65d. „ „

Fibres—*Contd.*

Hemp (sisal)	-	£25.10—£40 per ton.
Do. (Manila, J. Grade)	-	£34.10 „ „
Do. (New Zealand)	-	£33—£35 „ „
Kapok (Java)	-	1/4 per lb.
Do. (Indian)	-	1/1 „ „

Foodstuffs.

Cocoa (Ceylon, plantation)	-	60/-—100/- per cwt.
Coffee (Malay, plantation)	-	90/-—120/- „ „
Do. (Malay, Liberian)	-	60/-—70/- „ „
Sago (pearl)	-	28/-—30/- „ „
Do. (flour)	-	17/6—18/6 „ „
Sugar (white, Java)	-	52/- „ „
Tapioca (Penang, flake)	-	3½d.—3¾d. per lb.
Do. (do. flour)	-	18/-—22/- per cwt.

Miscellaneous.

Guttapercha (genuine)	-	2/9—6/- per lb.
Do. (Sarawak)	-	3/-—4/- „ „
Do. (Siak, reboiled)	-	9½d. „ „
Jelutong	-	£30—£60 per ton.

Chemicals.

Acetic acid (glacial)	-	£73—£74 per ton.
Do. (80% comml.)	-	£50—£52 „ „
Acetone (pure)	-	£120—£125 „ „
Ammonia (.880)	-	£32—£34 „ „
Calcium acetate (grey)	-	£22—£23 „ „
Citric acid	-	1/5—1/6 „ „
Creosote	-	9¼d. per gallon.*
Formalin (40% vol.)	-	£63—£64 per ton.
Lime Juice (raw)	-	1/9—2/6 per gallon.
Do. (conc.)	-	£21 per basis.†
Sodium bisulphite (60–62%)	-	£20—£22 per ton.
Sodium sulphite (anhydrous)	-	£26.10—£27.10 per ton.

* Basis = 108 gallons, 64 ozs. Citric acid per gallon.

† Given erroneously in January number as per. lb.

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